THE INTERNATIONAL JOURNAL OF BUSINESS & MANAGEMENT

China State-Owned Enterprises Residual Control Rights and Residual Claims Allocation: An Empirical Study Based on Incomplete Contract Theory

Shao Yujun
Ph.D. Candidate, School of Social Sciences, Tsinghua University, Beijing Shi, China

Abstract:
I apply the theory of incomplete contract, focus on the residual control rights and the residual claims of state-owned enterprises allocation, take asset-specific investment as the main line of paper, propose the special constrains of incomplete contract theory while applying on China, that is, develop and enrich the connotation and denotation of Incomplete Contract Theory. The paper builds a general mathematical model based on the modified theory of incomplete contract and takes the data of Tianjin Dredging Company(TDC) into empirical analysis, and obtains the sub-optimal solutions of residual control rights and residual claims allocation under constraint of China reality, the paper argues that the government should continue to hold on the shares of TDC, but should give the managers more residual control rights and residual claims so as to accelerate enterprise incentive mechanism and improve production efficiency.(JEL D86)

Keywords: China state-owned enterprises; residual contract rights; residual claims; incomplete contract theory

1. Introduction

The primary characteristics of China state-owned enterprises during the planned economy period are as follows: First, it's not clear of the property rights between enterprises and the government. It was always confused by Residual Control Rights, Residual Claims and Management Rights in enterprises. The government, which is the contributor or shareholder of state-owned enterprises, directly controls the day-to-day operation of the enterprise by controlling the financial, operating and personnel decision-making power. Kornai (1980) argued that there was a widespread problem of soft budget constraint in socialist countries. Enterprises cannot go bankrupt but could always be managed through subsidies or protection by the government. State-owned enterprises depend too much on the government. Second, mismatch on State-owned Enterprises function caused confusion of Corporate Governance Structure. The internal organization system lacks the vitality and motivation for self-development because of information asymmetry and incompatibility incentive. Third, resource allocation, production and management are decided by the government rather than the market, the border of property rights between enterprise and market was ambiguously.

In order to cope with the problems of state-owned enterprises in the planned economy, thoroughgoing reform should be taken into action. Shleifer (1997) argued that property rights reform will make enterprises more efficient. Xu Xin (2013) applied the game theory to analyze the property rights reform and its impact on performance through the Nash bargaining model. He believed that property rights reform was vital to the reform of state-owned enterprises.

The reform of property rights study has attracted the attention of many scholars in China, there are mainly two viewpoints: The one holds the view of property rights reform, and the other argues that market reform is the correct selection. Property rights reformists believe that the distortion of resource allocation in state-owned enterprises caused by the unclear property rights as well as the irrational property rights structure. Li Yining proposed the reform of shareholding system in 1980. Li Yining (1986) carried out the shareholding reform of state-owned enterprises in-depth analysis, which formed national ownership joint-stock reform ideas. Wu Jinglian (1993) suggested that the corporate property was not clear, corporate governance structure was irrational. Zhang (1997) found that there are significant differences in efficiency between public and private property rights. Zhang Weiying (1999) argued that the problem of poor performance of state-owned enterprises can be solved only by incentive mechanism and property rights reform. Megginson (2001) obtained the results by state-owned enterprises empirical research that privatization would improve the operation efficiency and profit of enterprises. Liu Xiaoxuan and Li Liying (2005), Hu Yifan (2006) all proposed that property rights reform can improve their business performance. Liu Jianhua and Wei Minghai (2010) obtained a clear demonstration of property rights. Li and Gao (2011) argued that property rights have an important impact on efficiency because they play an important role in transaction costs. Zhang Weiying (2015) argued that the government should transfer, distribute the shareholdings to private enterprises

or the general public in state-owned enterprises so that to enhance business efficiency, economic growth and solve social problems.

Market reformists think that the public and private property rights have no significant effect on the efficiency of state-owned enterprises. On the contrary, reducing the policy burden on state-owned enterprises and creating a fair market environment are the correct paths for the reform of state-owned enterprises. Svejnar (1990) found that the public or private ownership of the property has no significant effect on efficiency through the empirical test of the enterprise data. Lin et al. (2004) considered that reducing the social policy burden on state-owned enterprises and creating a fair market environment are the keys to the reform of state-owned enterprises rather than the reform of the property rights system. Liu Chun and Sun Liang (2013) argue that the ownership structure of an enterprise is not related to its operation efficiency. The solution to the problem of the efficiency in state-owned enterprises is to remove the social policy burden within state-owned enterprises.

It also has the research on state-owned enterprise reform practice in other countries. Dyck (1997) conducted an empirical study on the privatization of East Germany and concluded that the privatization process of East German enterprises increased the efficiency of enterprises because it's easy to find good professional managers after privatization, while it is difficult to find a suitable professional manager in the professional manager market during the period of government owned property rights. Professional managers are the key to corporate restructuring and improve business efficiency. Based on the experience of privatization in Eastern European countries, Sachs (1992) provided advice on the commercialization and privatization of Russia, he believed that the original equity should be distributed to employees or managers. Furthermore he suggested that the share of employees should not be lower than 25%, private ownership should be higher than 51%, and meanwhile the government should maintain a certain shareholding. Liberati (2005) conducted a study on privatization and family welfare in the United Kingdom. The empirical results show that the privatization of public utilities in the United Kingdom has very limited impact on family welfare and that privatization in the water and rail sectors has reduced the level of welfare. The above studies on the privatization of state-owned enterprises in the United Kingdom, East Germany, Eastern Europe and Russia show the following: First, the privatization of state-owned enterprises may have positive effects, such as the privatization process of German enterprises, It is also possible to have negative repercussions, such as the privatization of the water and rail sectors in Britain, and it is possible that the impact will not be obvious, such as the privatization of public utilities in the United Kingdom. Second, scholars proposed a diversified ownership structure, such as the suggestion of private and government shareholding for the process of commercialization and privatization in Russia, which provided reference for the reform of mixed ownership in China.

The above views on the reform of state-owned enterprises especially on the reform of state-owned property rights all concentrated on the following two aspects: normative and qualitative analysis. These two kinds of analyzes have their research advantages. For example, they can systematically grasp the megatrend of the reform from a macro-level as a whole, and can also draw the advantages and disadvantages of the reform and development of state-owned enterprises from the statistical laws, thus helping to formulate economic policies that are counter-questioning. However, researches pay too much attention to macro, holistic, tactical, metrological and empirical analysis, but lack of deep-seated micro-foundation analysis. Macro-analysis relies more on scholar's subjective judgment, and econometric analysis focuses too much on the study of statistical results. But it hasn't formed a set of theoretical system to deal with the reform of state-owned enterprises, particular on the reform of property rights of state-owned enterprises.

In order to make the study of property right reform of state-owned enterprises in a scientific, professional and effective way, the paper places special emphasis on the depth of theory especially of those micro-foundation and mathematical quantification methods.

The main model of the incomplete contract theory is GHM founded by Grossman, Hart, and Moore. The theory of incomplete contract holds the viewpoints that because of the uncertainties in the real world, the limited rationality of human being, the cost and the execution cost can't describe, so the contract is incomplete and the contract. From the point of GHM model, the residual claims and residual control rights of this indefinite part should be allocated to the party with larger asset-specific investment, that is, the property right should be allocated to the party with larger asset-specific investment.

The theory of GHM began with the study of Grossman & Hart (1986), who criticized and developed Williamson's acceptance of transaction costs and the limited rationality of the contract to make the contract incomplete. They thought that if the internal transaction costs less than the market, then all the companies can be merged into an integrated enterprise, which does not match the reality obviously. Therefore, Grossman and Hart argued that: First, in the complex and unpredictable real world, it is impossible for people to write down all the terms of the contract in the future. This is an unconfirmed cost. Second, all parties in the contract cannot write down payment and behavior in a common language. This is the indefinite costs. Third, even if both parties can write down all the acts and payments into the contract, the third party authorities remain having difficulty to judge and enforce it accordingly. This is the implementation cost. Therefore the contract is incomplete because of existence of the above three transaction costs.

In the GHM theory, which co-founded by Grossman & Hart (1986) and Hart & Moore (1990), realized that there is a contractual ambiguity in the incomplete contract and who he owns the residual control right will benefit more while the unclear event occurs. Therefore the allocation of residual control rights are the key core issues in incomplete contracts theory. Hart et al. argued that the party with residual control holds the upper hand in negotiations and therefore more willing to invest in assets. The other party lacks of incentives for asset-specific investment. So the residual control rights given to the

party with greater asset-specific investment productivity or elasticity is conducive to social welfare. GHM theory also holds the options that the residual control rights come from the residual control rights and residual claims of non-human capital. If the enterprise owns non-human capital, because of the glue, it can hold the workers and control the use of non-human capital, the residual control rights is the property right in essential. Since the enterprise is essentially a collection of non-human assets, the boundary of the enterprise is determined at the time when the varying of property rights makes the marginal revenue equal to the marginal cost.

GHM theory assumes the unpredictability of future conditions, however, future benefits are foreseeable. Thus, Maskin & Tirole (1999) and Maskin (2002) argued that participants cannot sign a complete contract through all possible future states, but they can sign a contract that relies on future returns and agree on ex post gambling rules in advance. If people meet the neutral welfare, the participants of the marginal utility meet the natural state of independence, efforts cannot be confirmed, or the behavior of people meet the risk-neutral conditions, then the unknowable, indefinable, impractical Contract have the same efficiency with full contract.

After MT, Hart et al further developed and extended the incomplete contract theory. According to Hart & Moore (2008), the contract provides a reference point for the economic behavior parties to experience the rights. Since then, Hart (2009) has used the notion of cost-of-attack to solve the problem of bargaining costs, arguing that transactions should be placed in the market or in enterprise interior. Hart & Holmstrom (2010) explained the role of authority on the basis of concession theory and used the theory to explain the actual problem of corporate mergers and acquisitions. Hart et al (2011, 2013, 2015) explain the real problems with the reference point theory of contract, which can make people understand deeply of a series phenomenon such as vertical integration, labor contract, collection and authority.

Hart & Moore (1999), Tirole (2009) relax the assumption of rationality and based on the assumption of bounded rationality, which is a more advanced model of rational anticipation choice.

Chinese scholars have introduced the theory of incomplete contract into the research of Chinese enterprises. Tang Ji-jun (2014) introduced the theory of incomplete contract into the issue of mixed-ownership reform of state-owned enterprises, and concluded that the reform of residual control rights and residual claims should be combined with the role of government, market, corporate and other factors. Xu Bin (2013) made a theoretical analysis of incomplete contract theory, specific investment and vertical integration. Xu Xi-bing and Wang Yong-hai (2013) applied incomplete contracts to the study of firm competence and internal control. Lv Chaofeng and Zhu Dandan (2016) applied the incomplete contract theory to study vertically integrated production of Chinese enterprises, they found that the positive correlation between the vertical integration of the enterprises and the financial development by using the panel data of the provinces and industries in China. Although these studies make some contribution to the theory of incomplete contract, the research on the application of incomplete contract theory in China is not deep. The assumptions, constraints and boundary conditions of theory should be further strengthened.

For the state-owned enterprises in China, the government holds all or part of the shares of the enterprise; state-owned enterprises has a greater reputation, influence and credit than other enterprises, which enable state-owned enterprises having more capacity to finance in the money market and the capital market. In addition, the government may make long-term or non-capitalized returns investment on state-owned enterprises. The first case giving above belongs to the intangible capital given by the political authority and the second case is the government social investment. These two situations are usually difficult to quantify. In order to solve the problem of state-owned enterprises property rights, we can learn from the theory of incomplete contract based upon GHM model, but the realities of China have their own constraints and need to be strictly modified and developed.

Based on the theory of incomplete contract, the paper argues that the government should grant the residual claim and residual control to which whose flexibility or productivity of asset-specific investment is larger while maintaining the existing shareholders. Compared with the incomplete contract theory, the two have in common: first, the contract is incomplete, and I agree the theory of incomplete contract on the basis of the incompleteness of the contract; second, the indefinite part of the contract corresponds to the residual Control rights and residual claims. Nevertheless, I develop the theory of incomplete contract based on China reality. The main innovations of the paper are as follows: Incomplete Contract Theory holds the opinion that property rights should be assigned to the higher-asset-specific investment parties However, when analyzing the actual situation of state-owned enterprises in China, we think that there exist the intangible capital such as credit, reputation as well as political authority brought by the government and the restraints of tangible economic benefits. We propose that the shareholders do no needs to vary, notwithstanding residual control rights and residual claims should assign to a party with a higher level of asset-specific investment productivity or sensitivity.

2. The General Mathematical Model

Because of information asymmetry, unknown future and indefinite description of the contract, the contract is incomplete, that is, the contract conclude both the descriptive part and the indefinable part, the indefinable part form the residual claim and residual control rights. The incomplete contract optimization theory is about the allocation of residual claim and residual control. At present, under the constraint condition, the center of state-owned enterprise reform is to change the allocation of residual control rights and residual claims so as to play more important role of residual claims and residual

control rights in encouraging and allocating resources, enhancing autonomy, flexibility and market of State-owned enterprises in China.

2.1. The Analysis on Government and State-Owned Enterprises Management Personnel Contract

As a contributor to State-owned enterprises, the government enjoys the residual control rights and residual claims of the enterprise. According to the reality in China, there are some particular constraints on the allocation of residual control rights and residual claim in China's state-owned enterprises while applying the incomplete contract theory. The state-owned enterprises residual control rights and residual claims should not only refer to the quantifiable boundary conditions such as the result of model analysis based on incomplete contract but also should be combined with intangible or non-quantifiable constraints, such as long-term substantial state-to-enterprise capital investment, the capital investment that disregard of cost, the political authoritative capital, social influence capital, the culture capital such and so forth.

As far as the economic functions of state-owned enterprises are concerned, the relationship between the government and the state-owned enterprises management personnel is similar to that of shareholders and enterprises management personnel in general enterprises. There exists information asymmetry and principal-agent problem. Government requires seeking effective contracts to solve the principal-agent problem. The management personnel and the government both face the problem of indefinite understanding of the future conditions, indefinite description of the contract, the third party cannot be fully implemented. The paper will demonstrate the sub-optimal solutions under these constraint conditions[1].

First, we assume that the government owns the asset a1 and management personnel own the asset a2, we also assume that:

- Both government and SOEs management personnel are risk-neutral;
- The initial wealth of government and SOEs management personnel is unlimited;
- The owners of the assets a1, a2 have both the residual claims and residual control rights of a1, a2.

We will use the concept of asset specific investment and show the sub-optimal allocation with the incomplete contract constraint.

Government makes asset specific investment such as infrastructure on SOEs, if the government deals with state-owned enterprises, the government's compensation is R (i), and the government's compensation income is R (i) -p, p is the price for the government to buy infrastructure from state-owned enterprises; Otherwise, if the transaction does not occur, the government needs to purchase infrastructure from the market. Infrastructure in the market is the non-asset-specific investment with purchase cost of q, the government compensation return is $r(i;\theta_1)$ and the net return is $r(i;\theta_1)$-q, where θ_1 is the government-owned resource. Similarly, we assume that state-owned enterprise management personnel make asset specific investment to government, such as purchasing machinery and equipment according to government projects. If the government deals with management personnel, the management personnel get p-C (e), C(e) is the cost of management personnel asset-specific investment to government, if the transaction does not occur, the SOEs management personnel access to q-$c(e;\theta_2)$. Where θ_2 is the management personnel-owned resource. Thus, assuming that the transaction takes place, the total revenue of the government and SOEs management personnel are R (i) -p + p-C (e). If the transaction does not occur, then the total revenue of the government and SOEs management personnel are $r(i;\theta_1)$-q+q-c(e;θ_2), we give a reasonable assumption that the total return on both sides is greater if transaction occurs than that transaction doesn't occur, which means R(i)-C(e)>r(i;θ_1)-c(e;θ_2). Here we also assume that the marginal return of asset-specific investment is increasing, that is: $R'(i) > r'(i;\theta_1,\theta_2) \geq r'(i;\theta_1) \geq r'(i;\phi)$ .where $R'(\cdot)$, $r'(\cdot)$ is the government marginal revenue of the asset-specific investment when owning assets, where $R'(\cdot) > 0$, $R''(\cdot) < 0$, $r'(\cdot) \geq 0$, $r''(\cdot) \leq 0$. Similarly, the marginal revenue of SOEs management personnel-to-government specific investment is also increasing, namely: $\left| C'(e) \right| > \left| c'(e;\theta_1,\theta_2) \right| \geq \left| c'(e;\theta_2) \right| \geq \left| c'(e;\phi) \right|$ .where $C(\cdot)$, $c(\cdot)$ is the marginal cost of SOEs management personnel -to-government specific investment when they owning the assets.

Now we assume that the government and SOEs management personnel reach the solution to the Nash bargaining after bargaining, which means both parties get the same 50% of profit, the compensation of the government and SOEs management personnel revenue are shown in formula (1) and (2) respectively:

$$\pi_1 = R(i) - p = r(i;\cdot) - q + 0.5[(R(i) - C(e)) - (r(i;\cdot) - c(e;\cdot))] = 0.5R(i) + 0.5r(i;\cdot) - 0.5C(e) + 0.5c(e;\cdot) - q \quad (1)$$

$$\pi_2 = p - C(e) = q - c(e;\cdot) + 0.5[(R(i) - C(e)) - (r(i;\cdot) - c(e;\cdot))] = q - 0.5C(e) - 0.5c(e;\cdot) + 0.5R(i) - 0.5r(i;\cdot) \quad (2)$$

Next, we discuss the optimal solution under a complete contract in which the information is complete, the two parties' actions can be fully coordinated, and the interests and actions are consistent. The overall revenue in this case is:

$$NP = R(i) - i - C(e) - e \qquad (3)$$

---

[1] The main References of the Proof are GHM Model and Incomplete Contract Theory founded by Hart et al.

In order to maximize the overall return, the vector $(i*, e*)$ must satisfy the first - order optimization conditions:

$$R'(i*) = 1 , \quad |C'(e*)| = 1$$

Now we seek the sub-optimal solution of the incomplete contract situation for the government and SOEs management personnel under the situation of asymmetric information. With Nash's bargaining solution, the government's net income is:

$$NP_1(i) = 0.5R(i) + 0.5r(i; \cdot) - 0.5C(e) + 0.5c(e; \cdot) - q - i \quad (4)$$

The net income of SOEs management personnel is:

$$NP_2(e) = q - 0.5C(e) - 0.5c(e; \cdot) + 0.5R(i) - 0.5r(i; \cdot) - e \quad (5)$$

To maximize NP_1 and NP_2 should satisfy $\dfrac{\partial NP_1(i)}{\partial i} = 0$, $\dfrac{\partial NP_2(e)}{\partial e} = 0$, Hence:

$$0.5R'(i) + 0.5r'(i; \cdot) = 1 \qquad （6）$$

$$0.5C'(e) + 0.5c'(e; \cdot) = -1 \qquad （7）$$

We give Lemma 1 below: Under the condition of incomplete contract and asymmetric information, the asset specific investment of government i and that of the SOEs management personnel e are both less than that of complete contract and complete information i * and e*[2]. Meanwhile, it is also assumed that the choice of residual control rights and residual claims depend on the maximization of total net income.

Next we give the definition 1, definition 2, lemma 2 and lemma 3 respectively.

---

[2] As the government owning assets θ_1, SOEs management personnel own assets θ_2, there will be the following three situations: First, the government merges the assets θ_2 of assets θ_1, in this case, the government own assets $\{\theta_1, \theta_2\}$, while SOEs management personnel own the assets $\{\phi\}$; Second, on the contrary, the SOEs management personnel merges the assets θ_1 of assets θ_2, in this case, the SOEs management personnel own assets $\{\theta_1, \theta_2\}$, while government own the assets $\{\phi\}$; Third, the government and SOEs management personnel have no merge to each other, that is, government own assets $\{\theta_1\}$, SOEs management personnel own the assets $\{\theta_2\}$ . . The sub-optimal equilibrium conditions in the first case are: $0.5R'(i_1*) + 0.5r'(i_1*; a_1, a_2) = 1$ $0.5C'(e_1*) + 0.5c'(e_1*; \phi) = -1$;The sub-optimal equilibrium conditions in the second case are: $0.5R'(i_2*) + 0.5r'(i_2*; \phi) = 1$, $0.5C'(e_2*) + 0.5c'(e_2*; a_1, a_2) = -1$. The sub-optimal equilibrium conditions in the third case are $0.5R'(i_3*; a_1) + 0.5r'(i_2*; a_2) = 1$, $0.5C'(e_3*; a_1) + 0.5c'(e_3*; a_2) = -1$ Since $R'(i) > 0.5R'(i) + 0.5r'(i; \cdot) = 1$, $C'(e) < 0.5C'(e) + 0.5c'(e; \phi) = -1$,then $i_j* < i*$, $e_k* < e*$ j=1,2,3,k=1,2,3.

The following is the proof of Lemma 2.

On the condition $\dfrac{\partial(\eta R(i) - i)}{\partial i} + \dfrac{\partial(\eta R(i) - i)}{\partial i}\dfrac{\partial i}{\partial e} > \dfrac{\partial(\kappa R(e) - e)}{\partial e} + \dfrac{\partial(\kappa R(e) - e)}{\partial e}\dfrac{\partial e}{\partial i} > 0$, if the ownership is given to the SOEs management personnel , for the same net equity change, the SOE sub-optimal solution is closer to the optimal solution, namely a higher degree of proximity $(i, e) \to (i*, e*)$. On the contrary, if $0 < \dfrac{\partial(\eta R(i) - i)}{\partial i} + \dfrac{\partial(\eta R(i) - i)}{\partial i}\dfrac{\partial i}{\partial e} < \dfrac{\partial(\kappa R(e) - e)}{\partial e} + \dfrac{\partial(\kappa R(e) - e)}{\partial e}\dfrac{\partial e}{\partial i}$, then the government sub-optimal solution is closer to the optimal solution, that is a higher degree of proximity $(i', e') \to (i*, e*)$. Where (i, e) is the government and SOEs management personnel asset-specific investment sub-optimal solution vector when the government obtains the shareholders; (i', e') is the government and SOEs management personnel asset-specific investment sub-optimal solution vector when the SOEs management personnel obtains the shareholders.

The following is the proof of lemma 3.

On the condition that $\dfrac{\partial(\eta R(i) - i)}{\partial i} + \dfrac{\partial(\eta R(i) - i)}{\partial i}\dfrac{\partial i}{\partial e} > \dfrac{\partial(\kappa R(e) - e)}{\partial e} + \dfrac{\partial(\kappa R(e) - e)}{\partial e}\dfrac{\partial e}{\partial i} > 0$, if the SOEs management personnel are given ownership, a higher degree of proximity $(i, e) \to (i*, e*)$ 。On the contrary, if $0 < \dfrac{\partial(\alpha(R(i) - i))}{\partial i} + \dfrac{\partial(\alpha(R(i) - i))}{\partial i}\dfrac{\partial i}{\partial e} < \dfrac{\partial(\beta(R(e) - e))}{\partial e} + \dfrac{\partial(\beta(R(e) - e))}{\partial e}\dfrac{\partial e}{\partial i}$, that is a higher degree of proximity $(i', e') \to (i*, e*)$.

Where (i, e) is the government and SOEs management personnel asset-specific investment sub-optimal solution vector when the government obtains the shareholders; (i', e') is the government and SOEs management personnel asset-specific investment sub-optimal solution vector when the SOEs management personnel obtains the shareholders.

Definition 1: If the optimal solution $\frac{1}{2} \leq \eta \leq 1$, $\max \eta R(i) - i$ is related to η , $\frac{1}{2} \leq \kappa \leq 1$, $\min \kappa R(e) - e$, is related to κ , and $\frac{\partial(\eta R(i) - i)}{\partial i} + \frac{\partial(\eta R(i) - i)}{\partial i} \frac{\partial i}{\partial e} > \frac{\partial(\kappa R(e) - e)}{\partial e} + \frac{\partial(\kappa R(e) - e)}{\partial e} \frac{\partial e}{\partial i} > 0$ then the investment i of the government is full of elastic compare to that of the SOEs management personnel; On the contrary, if $0 < \frac{\partial(\eta R(i) - i)}{\partial i} + \frac{\partial(\eta R(i) - i)}{\partial i} \frac{\partial i}{\partial e} < \frac{\partial(\kappa R(e) - e)}{\partial e} + \frac{\partial(\kappa R(e) - e)}{\partial e} \frac{\partial e}{\partial i}$ the government investment i is lack of elastic compare with that of the SOEs management personnel.

Definition 2: If $R(i)$ is replaced by $(R(i), i)$ with a weight vector of $(\alpha, 1-\alpha)^T$, $\alpha > 0$, $r(i; \cdot)$ is replaced by $(r(i; \cdot), i)$ with a weight vector $(\alpha, 1-\alpha)^T$; $C(e)$ is replaced by $(C(e), e)$ with a weight vector $(\beta, 1-\beta)^T$. $c(e; \cdot)$ is replaced by $(c(e; \cdot), e)$ with a weight vector $(\beta, 1-\beta)^T$, if $\frac{\partial(\alpha(R(i) - i))}{\partial i} + \frac{\partial(\alpha(R(i) - i))}{\partial i} \frac{\partial i}{\partial e} > \frac{\partial(\beta(R(e) - e))}{\partial e} + \frac{\partial(\beta(R(e) - e))}{\partial e} \frac{\partial e}{\partial i} > 0$ the SOEs management personnel is lack of productivity relative to government; on the contrary, if $0 < \frac{\partial(\alpha(R(i) - i))}{\partial i} + \frac{\partial(\alpha(R(i) - i))}{\partial i} \frac{\partial i}{\partial e} < \frac{\partial(\beta(R(e) - e))}{\partial e} + \frac{\partial(\beta(R(e) - e))}{\partial e} \frac{\partial e}{\partial i}$ the government investment is lack of productivity relative to SOEs management personnel.

Lemma 2: If the government's asset-specific investment is inelastic compare to SOEs management personnel, then the residual control rights and residual claims allocated to the SOEs management personnel is the best solution; on the other hand, if the government's asset-specific investment is more elasticity than that of SOEs management personnel, it is best to give residual control rights and residual claims to the government.

Lemma 3: If the government's asset-specific investment is lack of productivity compared to SOEs management personnel, then it is best to give residual control rights and residual claims to the SOEs management personnel; Conversely, if the asset-specificity of SOEs management personnel Investment is less productive than the government, then it is best to give residual control and residual claims to the government.

It can be concluded from the above analysis that under the condition of asymmetric information, participants imperfect prediction, indefinite description of contract, the deep reform of property rights depend on the indefinite part of contract, that is, residual claims and residuals Control rights allocation. If the sensitivity of government residual control rights and residual claims to asset-specific investment is higher than that of SOEs management personnel or if SOEs management personnel's investment productivity is lower relative to that of government, then the government have the residual control rights and the residual claims is a sub-optimal choice under the incomplete contract. On the contrary, if the sensitivity of government residual control rights and residual claims to asset-specific investment is lower than that of SOEs management personnel or if SOEs management personnel's investment productivity is greater relative to that of government, then the SOEs management personnel have the residual control rights and the residual claims is a sub-optimal choice under the incomplete contract.

2.2. The Analysis of Contract between SOEs Management Personnel and Employees in State-Owned Enterprises

In the state-owned enterprises, the contract between SOEs management personnel and staff is incomplete. There also exists the problem of information asymmetry between SOEs management personnel and employees, incomplete description of the future and the third party cannot fully implement. For example, the SOEs management personnel make asset specific investment to employees according to their qualifications, work experience, abilities and personalities. Employees also make specific investment to SOEs management personnel, such as making human investment accordance with the corporate culture, SOEs management personnel characteristics and so forth.

According to the above definition, if the SOEs management personnel asset specific investment is more flexible relative to that of employees, then it's the sub-optimal choice to give management personnel residual control rights and residual claims under incomplete contract conditions; on the contrary, if employees asset specific investment is more flexible relative to that of management personnel, it's the sub-optimal choice to give employee residual control rights and residual claims under incomplete contractual conditions. If the employee asset specific investment is lack of productivity compare that of SOEs management personnel, and then it's the sub-optimal choice to give the SOEs management personnel residual control rights and residual claims under incomplete contractual conditions. On the other hand, if the employee asset specific investment productivity is higher compare that of SOEs management personnel, then it's the sub-optimal choice to give the employees residual control rights and residual claims under incomplete contractual conditions.

Incomplete contract theory can optimize the structure of property rights and promote the reform of property rights of state-owned enterprises under the constraints of the participant's information asymmetry, incomplete expectations of the future, incomplete description of the contract, etc., furthermore, incomplete contract theory could play its role on optimize the allocation of property rights, improve incentive effectiveness and increase the overall net income.

According to the sensitivity analysis of the asset-specific investment above, the residual control rights and residual claims of the asset are allocated according to different situations. Table 1 shows the residual control rights and residual claims allocation according to sensitivity of asset Residual Control Rights and Residual Claim to Assets Specific Investment. Table 2 shows the residual control rights and residual claims allocation according to productivity of asset Residual Control and Residual Claim to asset-specific investment.

	The SOEs management personnel's residual control rights and residual claims are more sensitive to asset-specific investment than that of employees	The SOEs management personnel's residual control rights and residual claims are less sensitive to asset-specific investment than that of employees
The government's residual control rights and residual claims are more sensitive to asset-specific investment than that of SOEs management personnel	Government own the residual control rights and residual claims	uncertainty
The government's residual control rights and residual claims are less sensitive to asset-specific investment than that of SOEs management personnel	SOEs management personnel own the residual control rights and residual claims	Employees own the residual control rights and residual claims

Table 1: The Residual Control Rights and Residual Claims Allocation According to Asset Residual Control and Residual Claim Sensitivity to Assets Specific Investment

	The productivity of SOEs management personnel residual control rights and residual claims to asset-specific investment is higher than that of employees	The productivity of SOEs management personnel residual control rights and residual claims to asset-specific investment is lower than that of employees
The productivity of government residual control rights and residual claims to asset-specific investment is higher than that of SOEs management personnel	Government own the residual control rights and residual claims	uncertainty
The productivity of government residual control rights and residual claims to asset-specific investment is lower than that of SOEs management personnel	SOEs management personnel own the residual control rights and residual claims	Employees own the residual control rights and residual claims

Table 2: Residual Control Rights and Residual Claims Allocation According to Asset Residual Control and Residual Claim Productivity

2.3. The Analysis of Contract between SOEs Management Personnel and the Market

Similarly, table 3 shows the residual control rights and residual claims allocation according to asset Residual Control and Residual Claim Sensitivity to Assets Specific Investment among government, SOEs management personnel and market.

	The productivity of SOEs management personnel residual control rights and residual claims to asset-specific investment is higher than that of market	The productivity of SOEs management personnel residual control rights and residual claims to asset-specific investment is lower than that of market
The productivity of government residual control rights and residual claims to asset-specific investment is higher than that of SOEs management personnel	Government own the residual control rights and residual claims	uncertainty
The productivity of government residual control rights and residual claims to asset-specific investment is lower than that of SOEs management personnel	SOEs management personnel own the residual control rights and residual claims	markets own the residual control rights and residual claims

Table 3: Residual Control Rights and Residual Claims Allocation According to
Asset Residual Control and Residual Claim Sensitivity to Assets Specific Investment

	The productivity of SOEs management personnel residual control rights and residual claims to asset-specific investment is higher than that of market	The productivity of SOEs management personnel residual control rights and residual claims to asset-specific investment is lower than that of market
The productivity of government residual control rights and residual claims to asset-specific investment is higher than that of SOEs management personnel	Government own the residual control rights and residual claims	uncertainty
The productivity of government residual control rights and residual claims to asset-specific investment is lower than that of SOEs management personnel	SOEs management personnel own the residual control rights and residual claims	Market own the residual control rights and residual claims

Table 4: Residual Control Rights and Residual Claims Allocation According to
Asset Residual Control and Residual Claim Productivity

3. The Empirical Analysis on Tianjin Dredging Company (TDC) Property Right Reform

3.1. The Descriptive Statistics of TDC Property Rights Reform from 1978-2015

Since the reform and opening up in China, TDC experienced the China tax reform in 1983, 1984 and 1986. It has become a subsidiary of China Harbor Group from the China Ministry of Communications since 1998. In 2006, it became a subsidiary of China Communications Construction Corporation. The direction of TDC reform is from administrative to market in general since 1978, from fixed to flexible and from mandatory to autonomy. The ownership as a whole hasn't changed yet, but the TDC residual control rights and residual claims have been transferred. TDC mechanism shifts to market, flexibility and autonomy along with the residual control rights and residual claims were transferred to the enterprises.

From 1978 to 1992, the reform of state-owned enterprises in China initiated from the right of management[3]. In order to get rid of the problem that low viability in the enterprises under the traditional planned economy system, the government

---

[3] Although the Third Plenary Session of the 12th CPC Central Committee in October 1984 proposed that "Ownership should be properly separated from the right of operate", in October 1987, the 13th CPC National Congress proposed that "all enterprises owned by the whole people should be revitalized in accordance with the principle of separation of ownership and management rights", But the concept of top-level design has not yet entered the practical level before the fourteenth congress of the CPC..

set out to release part of the autonomy right to enterprises. The earliest pilot was in October 1978. Due to the inertia of ideology and history, the goal of the government reform was centered on the reform of the management right. The aim of the reform was to make the enterprise a "four self" enterprise that operate self-independently, self-responsibility, self-reform and self-development. The government implemented a certain motivating policy of delegation the power and profit, such as the profit-to-tax reform policy from 1983 to 1986[4], rationalize the distribution relationship between government and state-owned enterprises and enhance the enthusiasm of enterprises. From the perspective of incomplete contract theory, profits and taxes reform make the enterprise own a certain range of revenue residual claims.

China promulgated the management contract policy[5] in 1986, government endowed enterprises some output and revenue residual claims in order to enhance the enthusiasm of production. In the same year, TDC carried out "reforming enterprises" with greater autonomy and flexibility in enterprises and have more residual control rights and residual claims.

In 1993, TDC proposed the establishment of a modern enterprise system, gradually established a property right system, corporate governance structure and management system according to the market economy. State-owned enterprises became independent legal entity and market players, divesting functions belonged to the government, the market and the society. Stripping from corporate budget soft constraints and the non-economic function makes TDC become a real sense of the market enterprise entity. Under the dual role of system and policy dividends, as a member of the market economy, state-owned enterprises have shown its strong momentum of development[6].

In 1998, TDC departed from China Ministry of Communications and became a subsidiary of China Harbor Group. This transformation make TDC own more residual control rights and residual claims along with greater autonomy and flexibility.
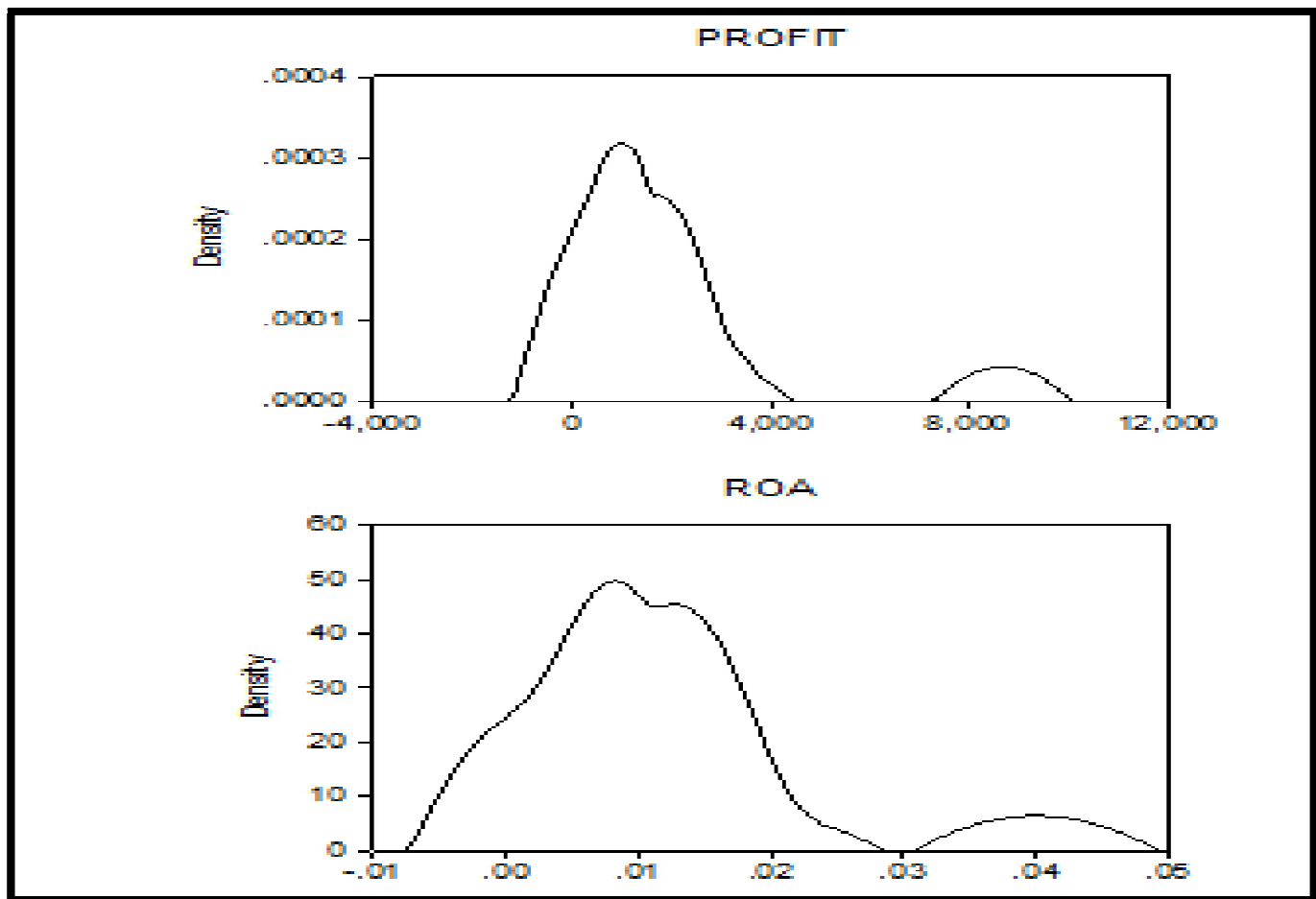

Figure 1: Nuclear Density Estimation of TDC Annual Profit and ROA[7] from 1993 to 2005[8]

[4] The "tax reform" introduced in 1983 set the central government a 55% income tax rate. After-tax profits were shared by the government and enterprises according to a certain percentage. Although the first step of tax reform has mobilized the enthusiasm of enterprises, the coexistence of profit and tax make it difficult to exert the leverage of taxation. Moreover, the 55% tax burden inhibits the enthusiasm and initiative of the enterprise's production and development. In September 1984, the State Council decided to implement the second step of "interest-to- tax reform," to fully mobilize the enthusiasm initiative and creativity of enterprises.

[5] In 1986, the State Council promulgated the "various forms of management responsibility contract system, giving abundant autonomy to managers."

[6] In November 2013, the Third Plenary Session of the 18th CPC Central Committee pointed out that "the state-owned enterprises as a whole have dissolved in market economy."

[7] ROA is the total return on assets, corporate profits and total assets ratio. The total profit unit is million RMB.

[8] The nuclear density estimation obeys the Epanechnikov nuclear density function.

In 2006, after nearly ten years of reform, the degree of marketization in China's state-owned enterprises has risen significantly. After becoming a subsidiary of China Communications Construction Corporation (CCCC), the marketization of TDC was further enhanced, the autonomy and flexibility of the enterprise were further strengthened. As a result, the residual claims and residual control rights obtained by the enterprises were significantly enhanced. In the years from 2006 to 2015, the Company has enjoyed a high-speed growth period in terms of profitability, business and financial performance. During these years, the company's net profit, total return on assets (ROA) and return on net assets (ROE) all hovered at a high level especially from 2008 to 2010, net profit grew rapidly,. ROA and ROE reach historic highs in 2010. In recent years, the advantages and dividend from the prosperity of the domestic economy, the advantages of monopoly in the market, economies of scale, credit advantages, channel advantages, talent advantage, resources advantages, capital advantage, research and technical superiority are dizzy. With the above advantages and superiority, TDC achieved its golden decade growth with the golden decade of economic development in China.
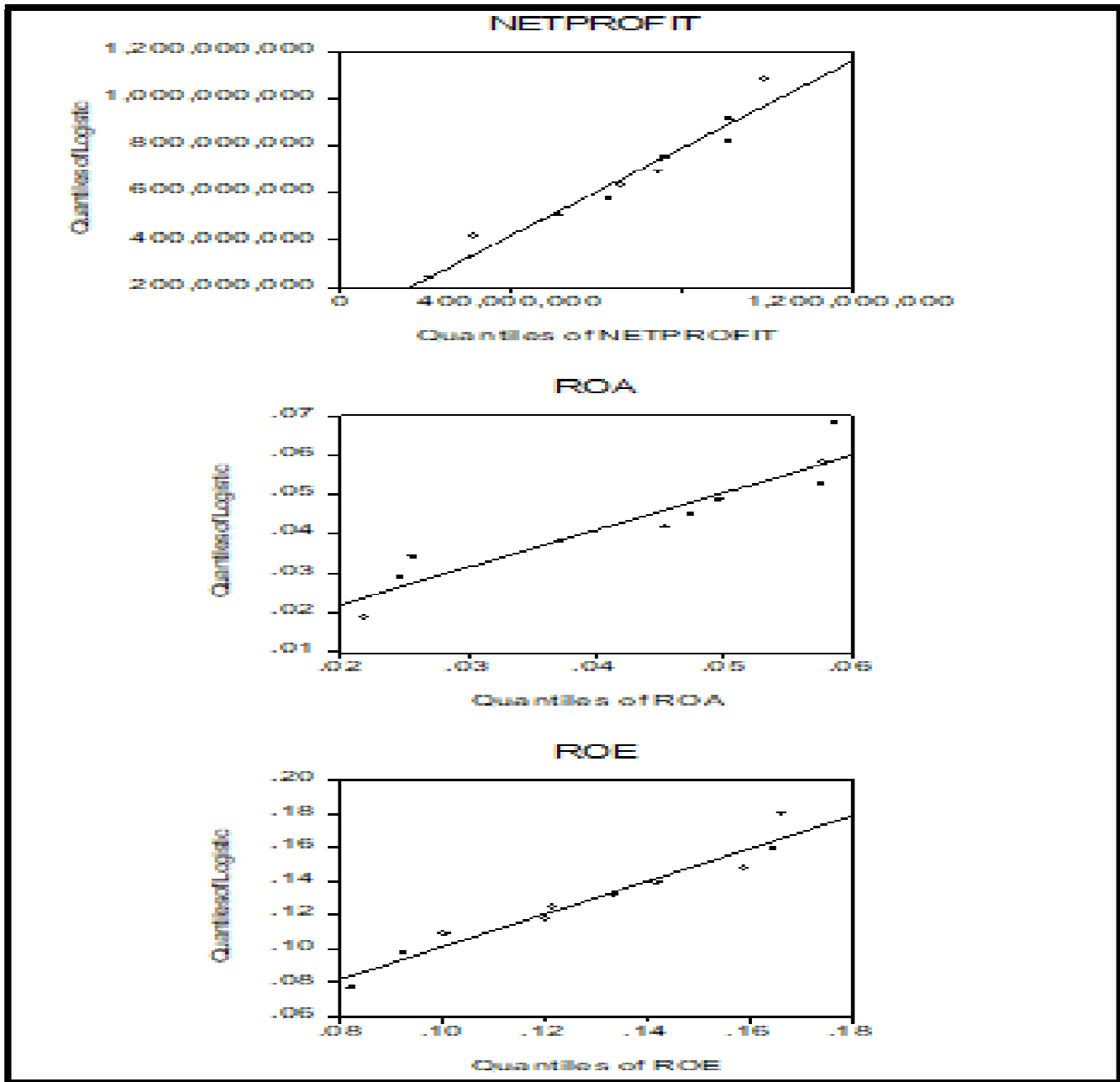

Figure 2: Net Profit, ROE and ROA[9] Quantile-Quantile Plot[10] of TDC from 2006-2015

---

[9] ROA is the return on total assets, that is, the ratio of total net profit of enterprises to total assets. ROE is the ratio of net profit to net assets. The total profit unit is million RMB.
[10] Here choose Logistic distribution.

3.2. Econometric Model

After going through the more in-depth reform of residual control rights and residual claims, TDC clarified the relationship of property rights among the government, TDC and the market. This is the primary reason for TDC ten golden years development. However, in recent years, the problems brought by the imperfect reform of property rights have caused TDC profit and operating performance decreasing in varying degrees. After 2011, the growth of net profit, ROA and ROE showed a decline compare that of 2008 to 2010, especially on the year 2011 and 2012, the decline tendency was even more remarkable. Although it started to stabilize and rebounded from 2013, it's clearly perceived that the growth momentum has been greatly reduced from the peak. The net profit, ROE and ROA Quantile-Quantile plot in 2006 - 2015 of TDC as shown in Figure 2 that it close to obey logistic distribution, the logistic distribution has the characteristics of convergence and stabilization, which confirms that net profit, ROA, ROE of TDC have the tendency of converge and stabilize, it also indicates that the TDC growth momentum tends to slow down.

According to the theory of incomplete contract, the ownership of residual control rights and residual claims of state-owned enterprises depend on the sensitivity and productivity of different entities when they own the residual control right and residual claims of assets respectively.

In the previous section, we demonstrate that the sub-optimal solution of residual control rights and residual claims allocation depend on the elasticity or productivity of asset-specific investment when they owning residual control rights and residual claims. We use the data of TDC subsidiaries, that are Coastal Corporation, Yantai Company, Engineering Company, South Company, East China Company[11], Sea Service Company, the Environmental Protection Division, the Overseas Division for empirical analysis. TDC is the second-tier subsidiary of China Communications Construction Company[12], Coastal Corporation, Yantai Company, Engineering Company, South Company, East China Company, Sea Service Company, the Environmental Protection Division, the Overseas Division are the third-level subsidiaries of China Communications Construction Company[13].

According to Williamson's (1975, 1979) definition of asset specificity, asset specificity is associated with the extent to which assets are used by others without diminishing production value. Asset specificity is related to the concept of sunk cost, but it is a derivative of an incomplete contract. Williamson (1996) classifies asset specificity as location specificity, physical asset specificity, human capital specificity, Specialized assets, brand equity and temporary specialization.

In order to transform the abstract conception of assets specific investment of the government, the SOEs management personnel[14], the employees into a measurable variable, we make the following assumptions:

- The asset-specific investment of government, the SOEs management personnel, employees and the market compose the set Z, Z is a well-ordered set, the asset-specific investment of the government, the SOEs management personnel, employees and the market are the subset of Z respectively. $\overline{zi} = \left\{ x \middle| x \square z_i \right\}$, (i=1,2,3,4) is the equivalence class represented by z_i. $Z/\square = \left\{ \overline{zi} \middle| z_i \square Z \right\}$ is the quotient set of Z mode $\square$, The set of TDC financial indicators Y is also a well-ordered set, and there is a binary relation R [15]between Z and Y. quotient set $Z/\square = \left\{ \overline{zi} \middle| z_i \square Z \right\}$ is the compact set on R^n, $f : Z \to Y$ is the continuous mapping on the set Z, so the mapping f satisfies the consistent and continuous conditions.

- Z and Y define the multiplication operation and satisfy the closeness, the combination law, the unique unit element and the inverse element, $f : Z \to Y$ keeps the basic operation law unchanged, that is, Z is isomorphic to Y, and the mapping f is an isomorphic mapping. We explain the relationship between quotient set $Z/\square = \left\{ \overline{zi} \middle| z_i \square Z \right\}$ and Y respectively.

- The government's asset special investment to TDC

The government's asset-specific investment to TDC can be mapped in TDC's bank loan. because the amount of bank loan depends largely on the state-owned background of the enterprise, the government's asset-specific investment to TDC can

---

[11] It instead by Shanghai company since 2014.

[12] CCCC's first-tier subsidiaries include CCCC Dredging and CCCC Dredging's first-tier subsidiaries include TDC.

[13] Considering the actual conditions constrains such as history, politics, society in China, ownership of state-owned enterprises refer both to the quantitative boundary conditions while it is necessary to combine intangible and non-quantitative constraints such as long-term substantial state-to-enterprise capital investment, return-disregarding capital investment, political authoritative capital owned by state-owned enterprises and their social influence capital when the government holds state-owned enterprises, Invisible and immeasurable capital formed on the basis of state-owned enterprises cohesion, aspirations and other human capital are the particular constrains of incomplete contract theory applied to China's state-owned enterprises. Accordingly, the Chinese state-owned enterprises in reality take the profit-oriented economic function and the national development strategy functions, so the government holding the ownership of state-owned enterprise is the optimal solution at this time. The mechanism and system of CCCC third-tier subsidiaries are close to marketization. The theory of incomplete contract is also based on mercerization. Therefore, it is applicable to do empirical evidence on incomplete contract theory with eight branches of TDC.

[14] TDC is represented by its eight subsidiaries.

[15] The binary relation means that the rule R is satisfied between the elements of two sets X and Y, that is, for any xRy, x and y conform to the rule R, or xy and x and y do not conform to the rule R, then the rule R is called The binary relation between the elements of X and Y.

me conceded as the monetary investment, the bank loans determine the company's asset-liability ratio to some extent, in general speaking, the higher the bank loan, the higher the debt ratio of enterprises. Here, we use the asset-liability ratio dta as a variable for the capacity to attract bank loans, it also represents the government asset-specific investment.

3.2.1. Management Personnel's Asset Specific Investment

There is a positive relationship between management personnel's asset specific investment and the operating ability of the company. The increasing of asset specific investment by management personnel, for example, enhancing the technology of the company, improving the management style, optimizing the organizational structure, designing a more reasonable development strategy, the introduction of incentive mechanisms will improve the operating ability of enterprises. Thus the higher the gross profit, the stronger ability of TDC's operating, the gross profit and TDC management personnel's asset specific investment have positive relationship, we use gross profit ratio on behalf of TDC management personnel's asset specific investment.

3.2.2. Employees' Asset-Specific Investment

The asset specific investment made by TDC employees such as learning and training adapt to enterprise, integrating into company management system, forming a harmonious enterprise spirit. Employees enhance their specific investment will enhance labor productivity; labor productivity increase can be expressed as an increase in staff wages[16]. Therefore, the employees' salary and their asset specific investment manifest the positive relationship, we use employee wages to represent the Employees' asset-specific investment to TDC.

3.2.3. Market Asset Specific Investment

The net profit ratio of an enterprise is an important factor that affects market asset specific investment to an enterprise. The higher the net profit ratio of a company, the more it can attract market investment, that is, the profit ratio is positively related to the market asset specific investment to the Company. Here, we choose the net profit ratio ROE to represent the market asset specific investment of the Company.

3.2.4. Flexibility or Productivity of TDC Asset-Specific Investment

The elasticity or productivity of TDC Asset-Specific Investment is represented by y (operating income - operating cost) / operating cost.

In order to compare the flexibility or productivity of different entities when they hold the residual control rights and the residual claims respectively, giving the econometric model following:

$$y_{it} = \beta_1 dat_{it} + \beta_2 gpm_{it} + \beta_3 w_{it} + \beta_4 roe_{it} + \mu_i + \gamma_t + \varepsilon_{it} \quad (8)$$

dat_{it} , gpm_{it} , w_{it} , roe_{it} respectively represent government , management, employees and the market Asset-Specific Investment to the Company i in year t, y_{it} is the asset-specific investment flexibility or productivity for Company i in year t.

β_i (i = 1,2,3,4) is the estimated parameters. μ_i , γ_t , ε_{it} respectively represent the fixed effect, fixed time effect and random perturbation.

3.3. Data description

3.3.1. TDC Asset-Specific Investment Elasticity or Productivity dat_{it}

Figure 3 shows the Quantile-Quantile plot[17] of TDC subsidiaries' assets liabilities ratio

---

[16] From the profit maximization condition, we get that when> 0, the equal sign is establshed. Or, that is. Therefore, assuming that P is constant, the growth rate of labor productivity is directly proportional to the growth rate of nominal wages of labor.
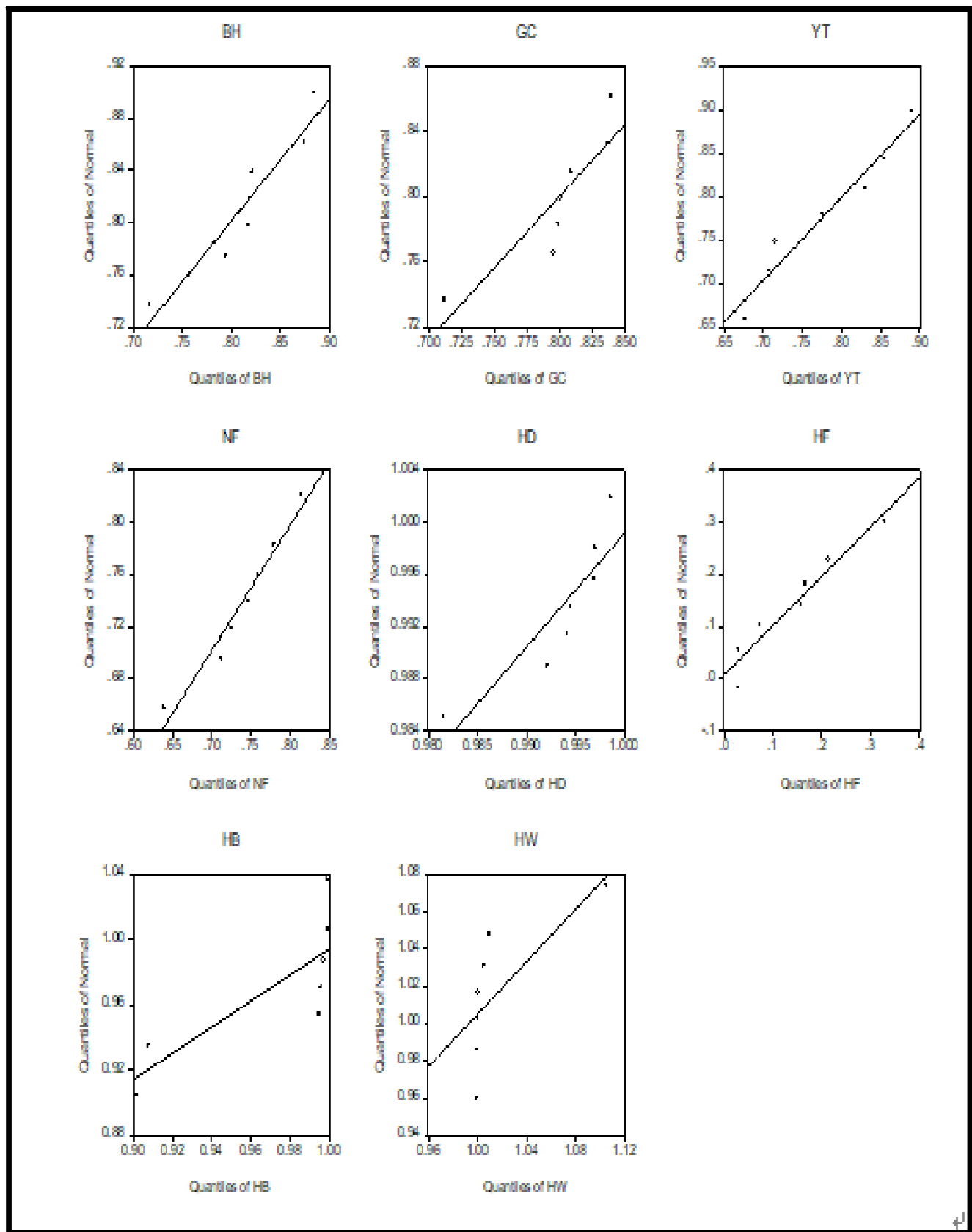[17]   Normal distribution here.

Figure 3: The Quantile-Quantile Plot[18] of TDC Subsidiaries' Assets Liabilities Ratio

---

[18]   Obey normal distribution here.

The Environmental Protection Division, the Overseas Division Elasticity or productivity do not obey the normal distribution yet. The other six companies, Coastal Corporation, Engineering, Yantai, South China, East China and the Sea Costal are close to obey normal distribution. From 2009 to 2015, China's money supply increased greatly. In 2009, the money supply of M2 was 61 trillion yuan. In 2015, the money supply of M2 exceeded 139 trillion yuan. The money supply mainly flows into the real economy in the form of bank loans. State-owned enterprises have high corporate value, financial strength, creditability. The bank's loan generally flow to state-owned enterprises. The increase of the money supply drives the increase of the he state-owned enterprises loan in China as well as their asset-liability ratio. As a state-owned enterprise, some major subsidiaries of TDC such as Coastal Corporation, Yantai and engineering companies have shown a trend of rising debt-to-asset ratio from 2009 to 2015.

3.3.2. TDC Management Personnel's Asset Specific Investment to TDC Gpm$_{it}$

The parent company of TDC, China Communication Construction Company (CCCC) was listed on the stock exchange in 2006; the corporate governance structure of CCCC was further improved. Chart 4 is the Quantile-Quantile plot[19] of management personnel's asset specific investment to TDC.
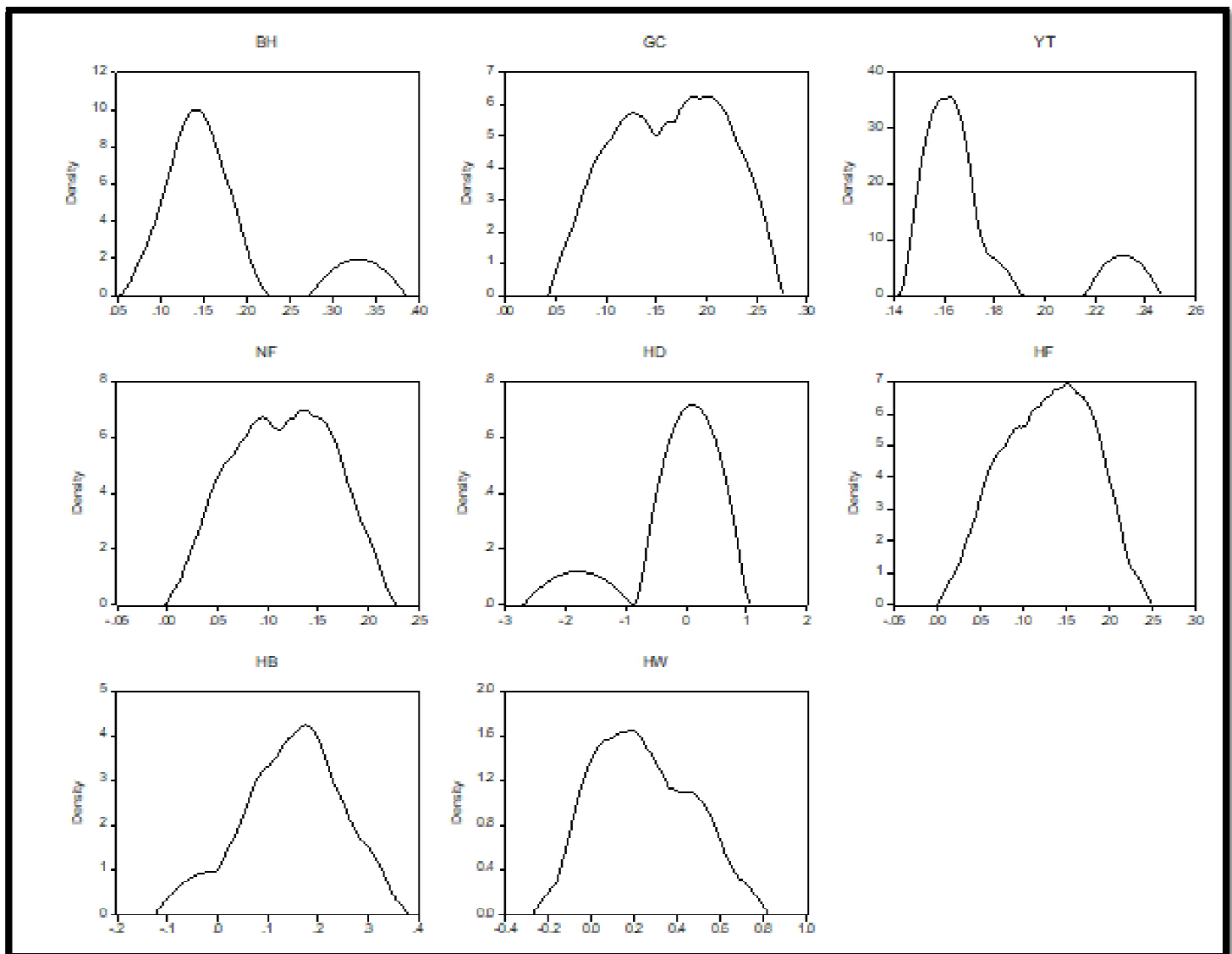

Figure 4: The Quantile-Quantile Plot of Management Personnel's Asset Specific Investment to TDC [2021]

---

[19]   Obey normal distribution here.
[20] The nuclear density estimation here is the Epanechnikov nuclear density function.
[21] BH, GC, YT, NF, HD, HF, HB and HW represent Coastal Corporation, Yantai Company, Engineering Company, South Company, East China Company, Sea Service Company, the Environmental Protection Division, the Overseas Division, respectively.

The three major subsidiaries of TDC, Coastal Corporation, Yantai Company, Engineering Company management personnel's asset specific investment fluctuated from 2009 to 2011 and showed an upward trend from 2012 to 2015. The other five company personnel's asset specific investment fluctuated more during the period from 2009 to 2015.

3.3.3. TDC Employees' Asset Specific Investment to TDC W_{it}

	BH	GC	YT	NF	HD	HF	HB	HW
Mean	15.05	13.36	12.28	17.37	22.6	7.13	21.74	29.72
Median	14.44	13.66	11.85	18.4	22.66	6.52	18.26	22.5
Maximum	18.32	14.77	16.57	20.57	33.8	17.11	37.96	68.71
Minimum	11.89	11.3	8.2	12.5	16.67	2.15	15.63	11.95
Std. Dev.	2.29	1.28	3.14	2.84	5.73	4.87	7.82	19.75
Skewness	0.17	-0.45	0.28	-0.67	1.02	1.25	1.44	1.14
Kurtosis	1.85	1.85	1.76	2.17	3.15	3.74	3.72	3.18
Jarque-Bera	0.42	0.62	0.53	0.72	1.22	1.99	2.56	1.53
Probability	0.81	0.73	0.77	0.7	0.54	0.37	0.28	0.46
Sum	105.38	93.55	85.99	121.57	158.22	49.92	152.2	208.04
Sum Sq. Dev.	31.59	9.84	59.22	48.56	197.17	142.29	367.34	2340.58

Table 5: TDC Employees' Asset Specific Investment to TDC W_{it}

As for the data statistics of the TDC employees' asset specific investment to TDC, Table 5 shows that there is a big gap between the different enterprises owned by TDC from the statistical indexes. Coastal Corporation, Yantai Company, Engineering Company are relatively less volatile while Sea Service Company, the Environmental Protection Division, the Overseas Division have high volatility, South Company, East China Company are in the median, it also shows that Coastal Corporation, Yantai Company, Engineering Company are in the period of large-scale increasing and stable development , While Sea Service Company, the Environmental Protection Division, the Overseas Division are still in the company's start-up period.

3.3.4. Market Asset Specific Investment to TDC

Figure 5 shows the market asset specific investment to TDC[22]. The four companies Yantai, South China, East China and the Sea Service are close to Logistic distribution, which indicating that market asset specific investment to these four companies tend to be more converge and stable than others.

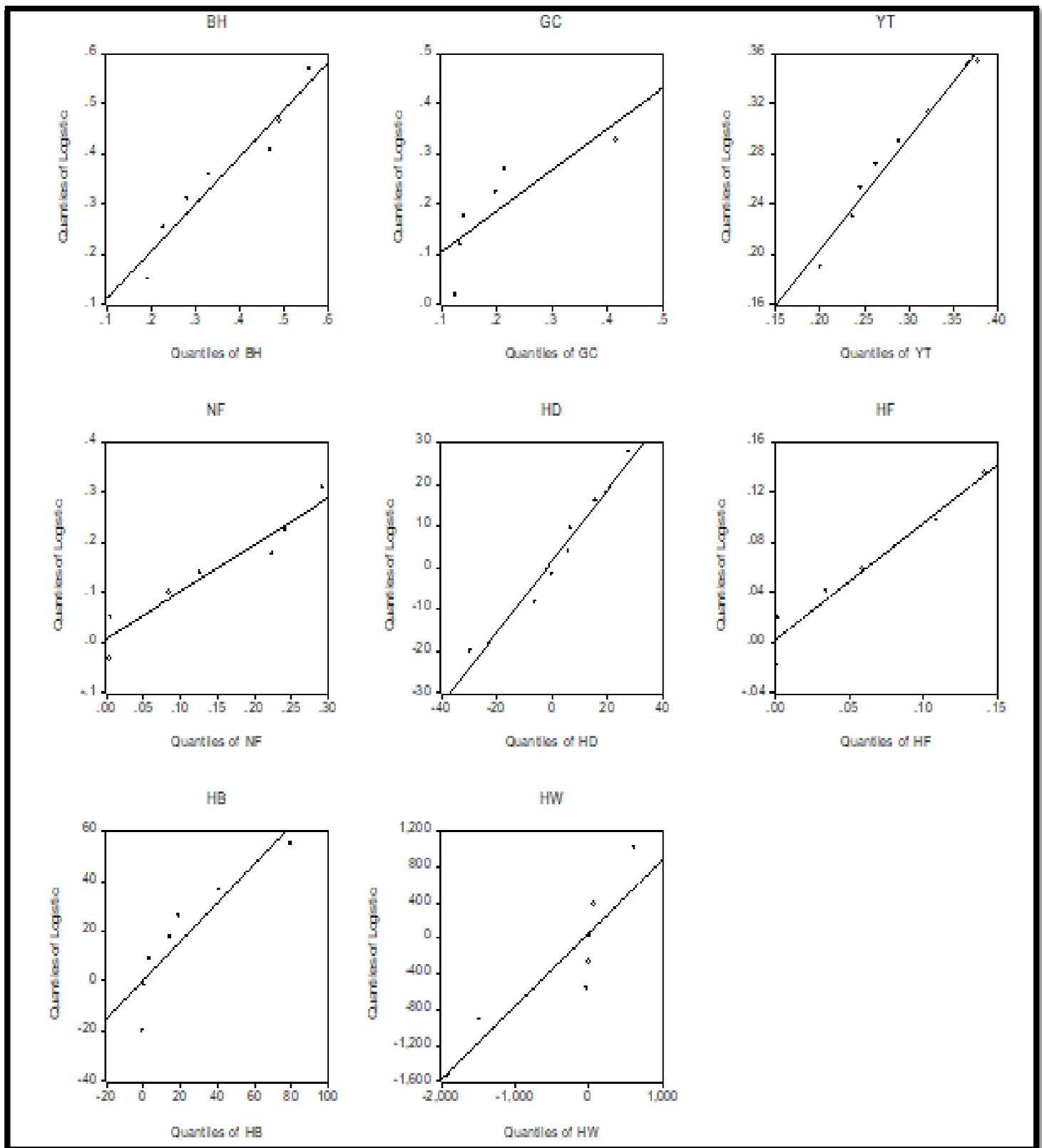[22]   Here choose Logistic distribution.

Figure 5: Market Asset Specific Investment to TDC

3.3.5. TDC Asset-Specific Investment Productivity or Elasticity

Figure 6 shows the histogram graph of TDC asset specific investment productivity. It can be seen that Coastal Corporation, Yantai Company, Engineering Company asset-specific productivity are relatively stable while the other five enterprises are more volatile ,which corresponding to the government, management, employees asset-specific investment.
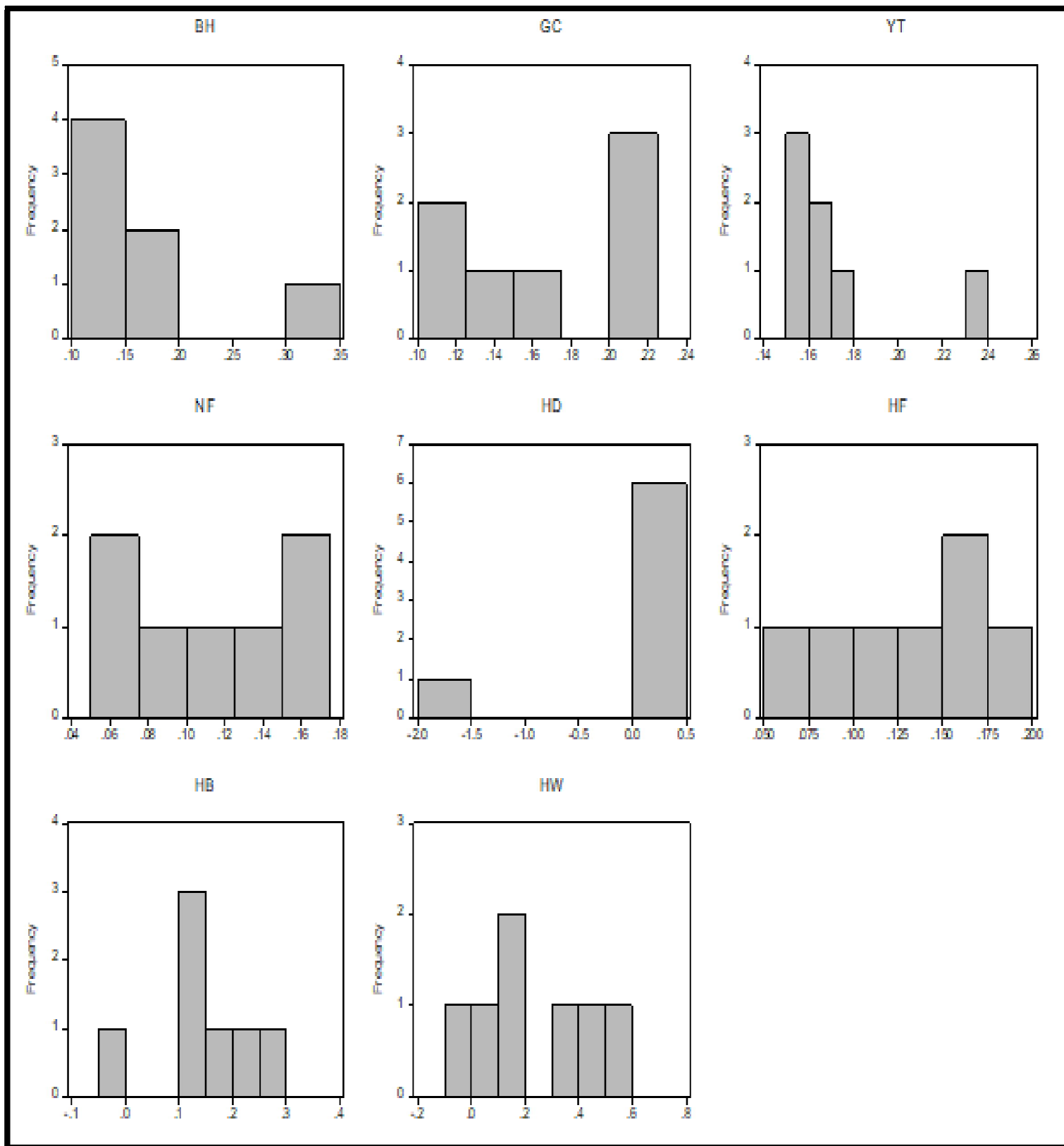
Figure 6: The Histogram Graph of TDC Asset Specific Investment Productivity

4.4. Empirical Evidence Results and Analysis

According to model designing $y_{it} = \beta_1 dat_{it} + \beta_2 gpm_{it} + \beta_3 w_{it} + \beta_4 roe_{it} + \mu_i + \gamma_t + \varepsilon_{it}$, we make descriptive statistics of variables by using enterprise panel data. The statistical results are shown in Table 6.

Variables	Implication	Mean	Std. Dev	Maximum	Minimum
dat	Government asset specific investment to TDC	0.78	0.27	0.03	1.1
gpm	Management personnel's asset specific investment to TDC	0.12	0.28	-1.8	0.56
w	Employees asset specific investment to TDC	17.4	10.13	2.14	68.71
roe	Market asset specific investment to TDC	-45.48	333.31	-1904.72	613.63
y	TDC asset-specific investment productivity	0.12	0.27	-1.8	0.56

Table 6: Descriptive Statistics of Variables

In order to avoid the problem of false regression in the model and to ensure the stability of the sample, we make a unit root test on the dependent variable y_{it} and the independent variables dat_{it}, gpm_{it}, w_{it} and roe_{it}. Meanwhile, in order to improve the credibility of the unit root test results, we also select the LLC, Fisher ADF, IPS and Breitung test simultaneously. The test results are shown in Table 7.

Variables	y	dat	gpm	w	roe
LLC	-0.01	-5.17***	-0.009	-5.42***	-7.59***
Breitung	3.25	1.37	3.24	0.94	0.02
IPS	1.31	0.1	1.3	0.12	-0.1
ADF-FISHER	13.58	16.35	13.58	16.34	19.3
PP-FISHER	30.02**	27.81**	30.02**	28.36**	40.89***

Table 7: Panel Unit Root Test

Note: Superscript *, **, *** represent significant at the confidence level of 10%, 5%, 1% respectively. The values in the table are the statistics of LLC, Breitung, IPS, ADF-FISHER and PP-FISHER test. The above tests are selected with intercept and trend items, the selection criteria are the Schwartz criteria.

The test results in Table 3 show that the dependent variable y_{it} and the independent variables dat_{it}, gpm_{it}, w_{it} and roe_{it} meet the significant at the confidence level of 5% of PP-FISHER test when tested by the method of LLC, Breitung, IPS, ADF-FISHER and PP-FISHER, dependent variables and independent variables can be considered stable from the test results.

Static panel data estimation methods include mixed effects model PRM, fixed effects model FEM and random effects model REM. First we select the enterprise and time two-factor fixed-effects regression model, the regression results shown in Table 8.

	FEM		REM
	enterprise and time FEM	enterprise FEM	enterprise REM
dat	-1.99E-16	0.00	-2.08E-17
	（-0.99）	(0.21)	(2.83)
gpm	1.00***	1.00***	1.00***
	（2.09）	(4.81E+16)	(5.35E+16)
w	7.07E-18***	0.00	1.12E-19
	（3.85）	(0.00)	(0.18)
roe	-4.21E-20	0.00	-3.86E-20**
	（-1.03）	(0.00)	(-2.52)
Prob(F)	0.000	0.000	0.00
Hausman test p-value			0.0000

Table 8: Regression Results of TDC Asset-Specific Investment
Productivity or Elasticity

Note: *, **, ***, represent significant at the confidence level of 10%, 5%, and 1% respectively. Parenthetical value is the t value of each explanatory variable.

The Hausman test shows that the firm and time fixed effects model is more significant. As seeing from Table 8, in the fixed-time enterprise model, as the explanatory variables, Management personnel's asset specific investment to TDC is more obvious than that of employees. TDC asset-specific investment productivity or elasticity is positive correlation of Management

personnel's asset specific investment. Moreover, neither the government nor market asset specific investment to TDC is obvious. Therefore, according to the theoretical model assumption, assign the residual control rights and residual claims to the management personnel are the second-best solution under the constraint condition.

4. Discussion

    Under the constraints, the asset-specific investment of incomplete contract theory can provide innovative ideas for TDC reform. Suppose that E1, E2, E3 and E4 represent the sensitivities of asset specific investment when government, management personnel, employees and market possess TDC residual control rights and residual claims receptively. If E1>Max {E2, E3, E4}, then the sub-optimal solution of the incomplete contract is to allocate the TDC residual control rights and the residual claims to government;

    If E2> Max {E1, E3, E4}, then the sub-optimal solution is to allocate the TDC residual control rights and the residual claims to TDC management personnel;

    If E3> Max {E1, E2, E4}, then the sub-optimal solution of the incomplete contract is to allocate the TDC residual control rights and the residual claims to TDC employees;

    If E4> Max {E1, E2, E3}, then the sub-optimal solution of the incomplete contract is to allocate the TDC residual control rights and the residual claims to market.

    Similarly, let P1, P2, P3 and P4 represent the productivity of asset specific investment when government, the management personnel, employees and the market possess TDC residual control rights and residual claims receptively. If P1>Max {P2, P3, P4}, then the sub-optimal solution with the incomplete contract is to allocate the TDC residual control rights and the residual claims to government;

    If P2> Max {P1, P3, EP4}, then the sub-optimal solution is to allocate the TDC residual control rights and the residual claims to TDC management personnel;

    If P3> Max {P1, P2, P4}, then the sub-optimal solution is to allocate the TDC residual control rights and the residual claims to TDC employees;

    If P4> Max {P1, P2, P3}, then the sub-optimal solution is to allocate the TDC residual control rights and residual claims to market.

    We can see from empirical evidence that the asset specific investment productivity or sensitivity is greatest while TDC management personnel possess the residual control rights and residual claim rights. Therefore, based on the incomplete contract theory, TDC management personnel possess residual control rights and residual claims is the sub-optimal solution.

    At present, the main factors restricting the long-term, healthy and stable development of TDC are the insufficient motivation of endogenous growth, the weak growth of total factor production, the difficulty of technological and management innovation. If TDC wants to seek a breakthrough under the constraint of limited resources, they still need to further emancipate their minds, integrate into the market economy much better, well play the advantages of market competition and incentive mechanisms. The effective use of incentive and competition mechanisms depends on whether the structure of property rights is reasonable or the structure of property rights is matched with the market economy system. Only when the system of property rights matches the market economy system can TDC effectively play the role of government, management personnel, employees and market's comparative advantages, and to substantial enhance the efficiency of TDC, increase the growth rate of total factor production, incentive endogenous growth, promote long-term and steady development.

    Incomplete contract theory is so effective to apply on the study of property right under the realistic constraints such as information asymmetry, incomplete participation, indefinite contract description etc. At present, China vigorously promotes the property right reform of state-owned enterprises. Not only government attracts the market capital to hold state-owned equity but also try to attract employees capital. The management's shareholding has been continuously exploring for a long time.

    I apply incomplete contract theory in the paper, construct the micro-foundation and demonstrate it in math. Who is the second best to own the TDC residual control rights and residual claims depend on their asset specific investment productivity and sensitivity. If the government has the greatest flexibility and productivity of asset-specific investment, TDC residual control rights and residual claims should allocate to the government. If the management personnel has the greatest flexibility and productivity in asset-specific investment, TDC residual control rights and residual claims should left to the management personnel; if the ordinary employees has the greatest flexibility and productivity for asset-specific investment, the ordinary employees have the residual control rights and residual claims is the sub-optimal solution; if the market has the greatest flexibility and productivity for asset-specific investment, it's best to allocate the residual control rights and residual claims to market. From the empirical evidence result we know that the management personnel has the greatest flexibility and productivity in asset-specific investment, so TDC residual control rights and residual claims allocated to the management personnel is the second best solution. What's important is that the TDC residual control rights and residual claims allocation should be dynamically adjusted as the actual situation changes.

    The government should continue to optimize the allocation of residual control rights and residual claims, give more residual control rights and residual claims such as designing equity incentive plan for management personnel, setting up a more incentive mechanism of the company, and giving more tangible incentives besides intangible income that entrepreneurs capacity can match the tangible and non- tangible income, so as to stimulate and mobilize the enthusiasm of the SOE's

production, promote the growth of the SOE's endogenous growth and achieve the long-term stable development of the state-owned enterprises.

5. References

i. Dyck, I.J. Alexander, 1997 "Privatization in Eastern Germany: Management Selection and Economic Transition". American Economic Review, 87(4):565-597.
ii. Fehr, E., O. Hart, C. Zehnder., 2011 " Contracts as reference points-experimental evidence." American Economic Review, 101(2): 494-525.
iii. Grossman, J.S. Oliver D. Hart, 1986 "The Costs and Benefits of Ownership: A Theory of Vertical and Lateral Integration." Journal of Political Economy, 94(4):691-719.
iv. Hart, O., John Moore., 1990 "Property Rights and the Nature of the Firm", Journal of Political Economy, 98(6):1119-1158.
v. Hart, O. & J. Moore., 2008 "Contracts as reference points", Quarterly Journal of Economics, 123(1): 1-48.
vi. Hart, O., J. Moore., 2009 Foundations of incomplete contracts ", Review of Economic Studies,66(1):115-138.
vii. Hart, O., 2009 "Hold-up, asset ownership, and reference points", Quarterly Journal of Economics ", 124(1): 267-300.
viii. Hart, O., B. Holmstrom., 2010 "A theory of firm scope", Quarterly Journal of Economics ", 125(2): 483-513.
ix. Hart, O., 2013 "Noncontractible investments and reference points", Games 4, pp. 437-456
x. Hart, O. & L. Zingales., 2015 "Liquidity and inefficient investment", Journal of the European Economic Association, 13(5):737-769.
xi. John Nash, 1950 "The Bargaining Problem", Econometrica, 18(2):155-162.
xii. Kornai, Janos., 1980 "Economics of Shortage", Amsterdam: North-Holland.
xiii. Liberati P., 2005 "UK Privatization and Household Welfare." Finanz Archiv / Public Finance Analysis,61(2): 220-255.
xiv. Maskin, E., Jean Tirole., 1999 "Unforeseen Contingencies and Incomplete Contracts," The Review of Economic Studies, 66(1):83-114.
xv. Maskin, E., 2002 "On Indescribable Contingencies and Incomplete Contracts," European Economic Review, 46(4-5): 725-733.
xvi. Megginsonw, Netter J. M., 2001 "From state to market: a survey of empirical studies on privatization", Journal of economic literature,39(2): 321-389.
xvii. Sachs, D., Jeffrey., 1992 "Privatization in Russia: Some Lessons from Eastern Europe", The American Economic Review, 82(2): 43-48.
xviii. Shleifer, A., Vishny R. W., 1997 "A survey of corporate government", Journal of Finance, 52(2): 737-783.
xix. Svejnan, Jay., 1990 "Productive efficiency and employment, In China's industry: Structure, Development, and reform", edited by William Byrd and Qinsong Lin. Oxford University Press.
xx. Tirole, J., 2009 "Cognition and Incomplete Contracts", The American Economic Review, 99(1):265-294.
xxi. Williamson, O.E, 1975, "Markets and Hierarchies: Analysis and Antitrust Implications", Free Press.
xxii. Williamson, O.E, 1979, "Assessing Vertical Market Restrictions." University of Pennsylvania Review,127(4): 953-993.
xxiii. Williamson, O.E, 1996 "The Mechanisms of Governance", Oxford University Press.
xxiv. Zhang, Gang. 1997, Chinese Rural Enterprises between Plan and Market, Ph.D. Dissertation, Stockholm School of Economics.
xxv. Hu Yifan, Song Min, Zhang Junxi, 2006: "Performance Privatization of Chinese State-owned Enterprises," Economic Research, No.7.
xxvi. Li Huai, Gao Lei, 2011: "Property Rights System" "Efficiency Life Cycle Hypothesis", "Economist" No.2.
xxvii. Liu Chun, Sun Liang, 2013: Policy Burdens, Market-based Reform and Performance Decline after Partial Privatization of State-owned Enterprises, "No. 1, Finance Research.
xxviii. Liu Jianhua, Wei Minghai, 2010: "Property Rights Constraints, Investment Options and Firm Performance: Intensive Management or Extensive Development", Contemporary Finance, No. 6.
xxix. Liu Xiaoxuan, Li Liying, 2005: An Empirical Analysis of the Impact of Restructuring on Firm Performance, China Industrial Economics, No.3.
xxx. Lu Chaofeng, Zhu Dandan, 2016: "Determinants of China's vertically integrated production model - An empirical study based on the perspective of financial development and incomplete contracts", China Industrial Economics, No.3.
xxxi. Li Yining, 1986: "Ownership Reform and Management of Share-holding Enterprises" and "Issue 12 of China's Economic System Reform".
xxxii. Lin Yifu, Liu Mingxing, Zhang Qi, 2004, "Soft Burden on Policy Burden and Firm Budget: An Empirical Study from China," and Management World, Issue 8.
xxxiii. Wu Jinglian, 1993: "Large and medium-sized enterprises to establish a modern enterprise system," Tianjin: Tianjin People's Publishing House.
xxxiv. Xu Bin, 2013: "Incomplete Contract, Specialized Investment and Vertical Integration", "Economic Survey" No.1.
xxxv. Xu Xin, 2013: "Research on the Efficiency of State-owned Property Reform Based on Dynamic Game", "Science and Technology Management Research" No.3.

xxxvi.   Xu XiBing, Wang Yonghai, 2013: Incomplete Contract, Corporate Competence and Internal Control, Auditing Research, No.6.

xxxvii.   Zhang Weiying, 1999: "Enterprise Theory and Chinese Enterprise Reform", Beijing: Peking University Press.

xxxviii.   Zhang Weiying, 2015: "Non-reform of state-owned enterprises cannot be changed", "Capital Market" No. 11.